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The Link Between Smoking, Lung Cancer and Socioeconomic Factors in Kentucky

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The Link Between Smoking, Lung Cancer and Socioeconomic Factors in Kentucky

CAPSTONE PROJECT PAPER

This paper submitted in partial fulfillment of the requirements for the degree of
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by
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Abstract

Background and Purpose

Lung cancer is the leading cause of cancer death and the second most diagnosed cancer in both men and women in the United States. An estimated 158,080 deaths from lung cancer are expected to occur in 2016, which will account for approximately 1 in 4 of all cancer deaths. The 1- and 5-year relative survival rates for lung cancer are 44% and 17%, respectively. The incidence rate for lung cancer has been declining since the mid-1980s in men, but only since the mid-2000s in women. Tobacco smoke is the leading cause of preventable disease and death in the U.S., which results in approximately 480,000 premature deaths and more than $300 billion in direct health care expenditures and productivity losses each year. Kentucky has the highest rate of lung cancer in the U.S. In 2012, the lung and bronchus cancer rate in the U.S was 60.4 per 100,000 and the rate in Kentucky was 92.4 per 100,000. Kentucky has the 2nd highest adult smoking rate in the U.S, at 27%. Socioeconomic status (SES) measures a person's social, economic and work status. It is measured by how many years a person has spent in school (less than high school, high school, college, graduate school etc.), how much money a person earns in a year, and whether the individual is employed or unemployed. A person's SES can affect his health status and their ability to get health care. The purpose of this study is to examine how education and income effect the smoking and lung cancer rate in Kentucky.

Methods

Data on lung cancer incidence and mortality was obtained from the Kentucky Cancer Registry Website. Data on smoking rates, median household income and high school graduate percent

was obtained from the Kentucky Health Facts Website. The data was analyzed using Excel, SPSS 23 for linear regression and ArcGIS 10.3 for mapping.

Results

There was a correlation between smoking and lung cancer mortality and between smoking and lung cancer incidence. Smoking was inversely correlated with education and income. Lung cancer incidence was inversely correlated with both education and income. There is an inverse correlation between lung cancer mortality and both education and income.

Conclusion

This is an ecological study and since it uses aggregate level data so it cannot be generalized to an individual living in the state of Kentucky. However, it can be inferred that smoking rates, lung cancer incidence and lung cancer mortality is higher when socioeconomic factors such as education and income are low.

INTRODUCTION

Lung cancer is the leading cause of cancer death and the second most diagnosed cancer in both men and women in the United States. (US & Group, 2015) The American Cancer Society estimates that in 2016 there will be an estimated 224,390 new cases of lung cancer, which will account for about 14% of all cancer diagnoses. An estimated 158,080 deaths from lung cancer are expected to occur in 2016, which will account for approximately 1 in 4 of all cancer deaths. (Society, 2016) Cigarette smoking is the number one cause of lung cancer. (US & Group) Other causes of lung cancer include using other types of tobacco (such as pipes or cigars); breathing secondhand smoke; diet low in vitamins; being exposed to asbestos or radon at home or at work; occupational exposure to nickel, chromium, arsenic, and polycyclic hydrocarbons; air pollution; familial and ethnic predisposition; chronic obstructive pulmonary disease and pulmonary interstitial fibrosis. (Kloecker, Studts, Laber, & Bousamra, 2007; US & Group, 2015)

The symptoms of lung cancer do not usually occur until the cancer is advanced, and may include persistent cough, sputum streaked with blood, chest pain, voice change, worsening shortness of breath, and frequent pneumonia or bronchitis. The American Cancer Society, along with the National Cancer Institute and the United States Preventive Services Taskforce recommends screening with low-dose spiral computed tomography, which has been shown to reduce lung cancer mortality by 20% when compared to standard chest x-ray among adults with at least a 30 pack-year smoking history who are also current smokers. The treatment for lung cancer is based on whether the tumor is small cell or non-small cell, as well as characteristics such as stage of cancer and molecular features of the cancer cells. The treatments for lung cancer can include a combination of surgery, radiation therapy,

chemotherapy, and targeted therapies. The 1- and 5-year relative survival rates for lung cancer are 44% and 17%, respectively. Only 16% of lung cancers are diagnosed at a localized stage, and at the localized stage the 5-year survival rate is 55%.(Society, 2016)

The incidence rate for lung cancer has been declining since the mid-1980s in men, but only since the mid-2000s in women (Society, 2016). In 2012, among men, Black men had the highest incidence rate of lung cancer, followed by White, Asian/Pacific Islander, American Indian/Alaska Native, and Hispanic men. Among women, White women had the highest incidence rate of lung cancer, followed by Black, American Indian/Alaska Native, Asian/Pacific Islander, and Hispanic women. (CDC, 2015) From 2008 to 2012, lung cancer incidence rates decreased by 3.0% per year in men and by 1.9% per year in women. (Society, 2016)

In 2012, among men, Black men were more likely to die of lung cancer than any other group, followed by White, American Indian/Alaska Native, Asian/Pacific Islander, and Hispanic men. Among women, White women were more likely to die of lung cancer than any other group, followed by Black, American Indian/Alaska Native, Asian/Pacific Islander, and Hispanic women (CDC, 2015). Lung cancer accounts for more deaths than any other cancer in both men and women. Lung cancer mortality rates have declined by 38% since 1990 in men and by 12% since 2002 in women due to the drop in smoking prevalence. From 2008 to 2012, the lung cancer mortality rates have decreased by 2.9% per year in men and by 1.9% per year in women. (Society, 2016)

Tobacco smoke is the leading cause of preventable disease and death in the U.S., which results in approximately 480,000 premature deaths and more than $300 billion in direct health care expenditures and productivity losses each year. According to the CDC's National Health

Interview Surveys' results, in 2014, nearly 17 of every 100 U.S. adults aged 18 years or older (16.8%) were current smokers, which translates to an estimated 40 million adults in the U.S. who currently smoke cigarettes. The rate of current smoking has declined from nearly 21 of every 100 adults (20.9%) in 2005 to nearly 17 of every 100 adults (16.8%) in 2014. Men are more likely to be current cigarette smokers than women, approximately 19 of every 100 adult men (18.8%) and 15 of every 100 adult women (14.8%) smoke. Current cigarette smoking was higher among persons aged 18–24 years, 25–44 years, and 45–64 years than among those aged 65 years and older. Nearly 17 of every 100 adults aged 18–24 years (16.7%), 20 of every 100 adults aged 25–44 years (20.0%), 18 of every 100 adults aged 45–64 years (18.0%), and nearly 9 of every 100 adults aged 65 years and older (8.5%) were current smokers. The rate of cigarette smoking was highest among non-Hispanic American Indians/Alaska Natives and people of multiple races and lowest among Asians. Current cigarette smoking was highest among persons with a graduate education degree certificate (GED) and lowest among those with a graduate degree. Current cigarette smoking rate was higher among persons living below the poverty level than those living at or above this level. More than 26 of every 100 adults who live below the poverty level (26.3%) and about 15 of every 100 adults who live at or above the poverty level (15.2%) were current smokers. Current cigarette smoking was higher among persons with a disability/limitation than among those with no disability/limitation. Approximately, 22 of every 100 adults who reported having a disability/limitation (21.9%) and about 16 of every 100 adults who reported having no disability/limitation (16.1%) were current smokers. (Jamal et al., 2015)

The harmful effects of smoking are not just limited to the smoker. More than 88 million non-smoking Americans, including 53% children aged 3-11 years are regularly exposed to secondhand or passive smoke. Some studies have shown that there is a positive link between secondhand smoke (SHS) exposure and coronary heart disease and death, and decreases in the exposure of SHS decreases the risk of acute myocardial infarction. In 2010, the Surgeon General provided evidence that there is no safe level of exposure for SHS because brief exposures can be extremely harmful because non-smokers can potentially inhale dozens of carcinogens and toxins present in cigarette smoke. Smoking during pregnancy has been related to infertility, low birth weight, stillbirth, preterm delivery, and Sudden Infant Death Syndrome (SIDS). (Health, 2012)

Kentucky has the highest rate of lung cancer in the U.S. In 2012, the lung and bronchus cancer rate in the U.S was 60.4 per 100,000 and the rate in Kentucky was 92.4 per 100,000 (US & Group, 2015). According to the 2012 report on Tobacco Use in Kentucky, the prevalence of smoking in Kentucky has decreased more than 20% from the rates in 2002, when the prevalence rate was 32.6%. Kentucky has the 2nd highest adult smoking rate in the U.S, at 27%. Additionally, 24.3% of pregnant mothers, 9% of middle school students, and 26.6% of high school students in Kentucky are current smokers. Each year approximately 8,000 Kentuckians die of illnesses caused by smoking, which include about 3400 deaths due to cancer, 2500 deaths due to cardiovascular disease and 2000 deaths due to respiratory illnesses. Some estimates say that 20% of all deaths in Kentucky can be attributed to smoking. On Average, approximately 14.8 years of life were lost among Kentucky adults who died as a result of smoking-attributable illness.

Smoking accounts for $1.77 billion in excess personal medical care expenditures, smoking related premature death accounts for $2.63 billion in productivity losses, and $1.2 billion in productivity losses is attributable to smoking related illnesses. Approximately $5.6 billion was the total estimated economic impact of smoking in Kentucky, 2012. It is estimated that every household in Kentucky pays $595 per year in federal and state taxes to support the economic burden of tobacco. (Health, 2012)

Over the last fifty years, there have been significant declines in cigarette smoking among U.S. adults, but the progress has slowed down, and there has been an increase in the use of e-cigarettes. According to the 2012-2013 National Adult Tobacco Survey, 21.3% of U.S. adults used tobacco products almost every day and 25.2% used them some days or rarely. Interventions such as tobacco price increases, anti-tobacco media campaigns, comprehensive smoke free laws, access to help with quitting, FDA regulations of tobacco products have all contributed to reducing the number of tobacco related disease and death in the U.S. (Agaku et al., 2014)

LITERATURE REVIEW

Socioeconomic Status (SES)

Socioeconomic status (SES) measures a person's social, economic and work status. It is measured by how many years a person has spent in school (less than high school, high school, college, graduate school etc.), how much money a person earns in a year, and whether the individual is employed or unemployed. For example, a person with a high SES may have a graduate school degree, higher than average income and steady full-time job, whereas a person with a low SES may have less than a high school education, not have enough money to lead a

comfortable life and be unemployed or work in a low-paying job. A person's SES can affect his health status and their ability to get health care. A person with a high SES is more likely to have insurance and sick leave through their employment, and therefore more likely to have access to preventative services such as cancer screening and tobacco cessation services. Research has also found that people with a high SES are more likely to have higher survival rates because they are prone to early cancer diagnosis and treatment. On the other hand, people with a low SES may not get necessary cancer screenings and have cancer diagnosed at later stages, which in turn leads to lower cancer survival rates. People with a low SES may not go to the doctor for a variety of reasons which include, not having access to transportation for a doctor visit, being worried about their screening tests, not being able to take off work to go see a doctor, etc. (CDC, 2014b) Socioeconomic factors such as poverty, insufficient education, lack of access to health care and health insurance, in some instances are more important than biological differences between people, and contribute to the health disparities in cancer burden that is present in society. (Ward et al., 2004)

Smoking and SES

There is a higher concentration of smokers among people in lower SES. The prevalence of smoking increases with decreasing SES. In a prospective birth cohort study conducted in Rhode Island, researchers found that the influence of SES on persistent smoking accumulates over the individual's lifespan. The results from their study showed that lower SES was associated with increased odds of first cigarette use (OR 1.51 vs high SES), lower adult SES increased the probability of progression to becoming a regular smoker (OR 1.06 vs high adult SES), and an individual's educational attainment was associated with regular smoking habits

(OR 1.25 vs high educational attainment). The limitations of the study include recall bias, since the researchers relied on the individual's response on when they first starting using cigarettes and when they progressed to regular use.(Gilman, Abrams, & Buka, 2003) In a study conducted in Tennessee, examining the association between SES and smoking, researchers found that individuals who had some college or more education were 0.60 times more likely to smoke when compared to individuals who had a high school degree or less ($p<0.01$). The study also found that participants belonging to neighborhoods with higher education levels were less likely to smoke. On the other hand the authors pointed out that African-Americans living in high income (>$26,500) neighborhoods were 2.10 times more likely to smoke than participants from moderate income ($20,001-26,500) neighborhoods ($p<0.003$) and 3.07 times more likely to smoke than participants from low income (<$20,000) neighborhoods ($p<0.0001$). One of the main limitations of this study was that the majority of the study participants were from low income and low-education neighborhoods which made it difficult to generalize the results for other populations across the U.S.(Scarinci, Robinson, Alfano, Zbikowski, & Klesges, 2002) In a study assessing the effect of education on smoking, researchers in Europe categorized education into high and low education, the high education group contained people who were college graduated or had professional degrees and the low education group contained people with no education or people who never finished high school. In their analysis the authors found that when compared to the high educated group, current male and female smokers in the low education group had odds ratios of 1.65 and 1.18 respectively. This indicates a higher prevalence of smoking among the low educated group. One of the main limitations of this study was the use of self-reported data which could lead to recall bias, as well as there was a high

non-response rate in the study which could underestimate the total prevalence rate of smoking. (Cavelaars et al., 2000) In a prospective cohort study conducted over the course of 7 years across 4 metropolitan areas in the U.S., researchers found that access to health care had a significant effect on the prevalence of smoking. In the study they found that people with a high school education had a 19% prevalence of smoking compared to 46% for people without a high school education. When the authors looked at income, people with an income greater than $50,000 had a 15% prevalence, those with an income between $25,000 and $50,000 had a 24% prevalence and people with an income less than $25,000 had a 39% prevalence of smoking. A major limitation of this study is that the data was only collected from major urban areas in the U.S, therefore is not generalizable to the entire U.S. population. (Kiefe et al., 1998) In a study conducted in Finland, researchers found smoking was very common among study participants that had low education, low income, economic difficulties and economic dissatisfaction. The prevalence of smoking across the college, high school and less than high school levels were 23%, 26% and 35% for men and 13%, 20%, and 30% for women respectively ($p<0.001$). The odds ratio for smoking was 1.73 for men, and 2.92 for women belonging to the lowest education level when compared to those who had college degrees. The odds ratio for smoking amongst the lowest income level was 2.04 for men and 1.58 for women when compared to the highest income level. Education level is an important socioeconomic indicator because it reflects the skills and knowledge that is required to make healthy choices such as those concerning smoking. (Laaksonen, Rahkonen, Karvonen, & Lahelma, 2005) In a study conducted in Netherlands that examined the effects of socioeconomic inequalities on smoking prevalence, initiation and cessation, the researchers found that lower educated respondents

were more likely to be smokers, have higher initiation ratios and lower quit ratios than higher educated study participants. The prevalence of smoking was 29% among lower education participants compared to 20% among higher educated participants, and 28% among people belonging to a low income level compared 24% in people belonging to a high income level. For men the odds ratio of smoking was 1.84 and for women the odds ratio was 2.26 in the low education group when compared to the high education group. Examining the effect of income, the odds ratio was 1.49 for men and 1.83 for women in the lowest income group compared to the highest income group. One of the limitations of this study is that 21% of the study respondents had unknown income levels and hence were excluded from the study, which could introduce selection bias in the study. (Nagelhout et al., 2012)

Risk of Lung Cancer and SES

Factors such as education and income level and social class have a significant effect on an individual's overall health. In a national case control study conducted in Canada, researchers found that the odds of having lung cancer among both males and females was significantly higher among people belonging to a low income background (OR 1.7 for males and 1.5 for females, $p<0.0001$). Both male and female study participants who had more than 14 years of education had an odds ratio of 0.6 when compared to those who had less than 8 years of education ($p<0.0001$). The study also concluded that males who had unskilled jobs and belonged to a lower SES had substantially higher odds of having lung cancer when compared to males who had a professional job and belonged to a higher SES (OR 1.9, $p<0.0001$). Some of the limitations of the study include low response rate among the participants that might lead to some selection bias, of the approximately 5300 questionnaires that were sent out the study

only had a response rate of roughly 62%, as well as there was a wide variation between the different Canadian regions represented. (Mao et al., 2001) In a case-control study to assess the risk factors for lung cancer in Iowa women, the authors found that women who had a college education had 0.63 times the odds of having lung cancer. The main limitation of the study was a response rate of 52%, which could lead to selection bias in the study. (Neuberger, Mahnken, Mayo, & Field, 2006) In a Swedish prospective cohort study, the authors found that the relative risk of lung cancer was 1.39 and 1.59 for men and women current smokers, respectively, when the low SES group was compared to a high SES group. The study also found that the case-fatality rate of lung cancer was 89% for men and 78% for the women, over the course of the study period. The researchers in this study tried to classify the participants between low and high SES and did it on the basis of education, income and occupation, which was one of the main strengths of study but in their exclusion criteria they could not classify self-employment and farmers, which did lead to selection bias in the study. (Ekberg-Aronsson, Nilsson, Nilsson, Pehrsson, & Lofdahl, 2006)

Late stage diagnosis of lung cancer is associated with poor long term survival. Many factors can contribute to late stage diagnosis, including living in socioeconomically disadvantaged neighborhoods where there is low utilization of screening services. Also, low levels of education have been linked with reduced awareness about screening services. In a study where the researchers assessed the differences among stage of cancer diagnoses between 4 SES categories (1) working, poor (WP); (2) working, non-poor, uneducated (WNP-U); (3) working, non-poor, educated (WNP-E); and (4) professional (Pr). They found that SES predicted lung cancer stage at diagnosis. Patients belonging to the Pr SES group were 22% less

likely than the (WP) SES group to present with non-local cancer diagnosis. WNP-E, non-poor, educated and WP-E groups had odds ratios of 0.76 and 0.79 respectively, for early stage lung cancer diagnosis, when compared to the WP group. In this study it was concluded that SES was an independent predictor of the stage of diagnosis. The cases of lung cancer from the highest SES group (Pr) were more likely to present with local stage disease than from the cases from the lowest SES group (WP). One of the major limitations of study was the use of aggregate level data to measure individual SES level, which could distort some of the associations seen in the study. (Schwartz, Crossley-May, Vigneau, Brown, & Banerjee, 2003)

In a case-control study where cancer patients diagnosed in one of eleven SEER registries were linked with 26 National Longitudinal Mortality Study cohorts, the authors found that women with less than a high school degree and just a high school degree had lung cancer rate ratios of 2.02 and 1.74 respectively, when compared to women who had a college education; men with less than a high school degree and just a high school degree had lung cancer rate ratios of 3.01 and 2.32 respectively, when compared to men who had a college education. When the authors looked at family income across the following categories: <$12,500, $12,500-$24,999, $25,000-$34,999, $35,000-$49,999, and >$50,000, for men the lung cancer rate ratios were 1.71, 1.61, 1.60 and 1.09 and for women the lung cancer rate ratios were 1.77, 1.40, 1.14, and 1.25 when compared to the >$50,000 income category. One of the limitations of the study was that the authors measured socioeconomic characteristics at the time of diagnosis, instead they should have attempted to measure the socioeconomic position that was accumulated over time which would provide a better understanding of the overall SES of the people in the study. (Clegg et al., 2009)

METHODS

This is an ecological study designed to understand the link between smoking, lung cancer and socioeconomic factors. For the purposes of this study data was obtained on five variables from different sources.

Adult Smoking

Data on prevalence of adult smoking was obtained as percentages from the Kentucky Health Facts website. The website which is run by the Foundation for a Healthy Kentucky compiled data for all 120 Kentucky counties from the CDC's Behavioral Risk Factor Surveillance System (BRFSS).

BRFSS is a health related telephone survey that collects state data on health-related risk behaviors, chronic health conditions and the use of preventive health services. It completes 400,000 surveys and collects data from all the 50 states, the District of Columbia and three U.S. territories. (CDC, 2014a)

Lung cancer Incidence

Data on age-adjusted lung cancer incidence rate per 100,000 was obtained from the Kentucky Cancer Registry website which compiles data for all 120 Kentucky counties, based on the number of lung and bronchus cancer cases that occur across the counties.

Lung cancer Mortality

Data on age-adjusted lung cancer mortality rate per 100,000 was obtained from the Kentucky Cancer Registry website which compiles data for all 120 Kentucky counties, based on the number of deaths that occur from lung and bronchus cancer, across the counties.

High School Education

Information on education across the 120 Kentucky counties was obtained from the data on the proportion of high school graduates (adults age 25 or older) from the Kentucky Health Facts website. The website compiled data from the American Community Survey conducted by the U.S. Census Bureau.

Median Household Income

Information on median household Income across the 120 Kentucky counties was obtained from the data on the median household income from the Kentucky Health Facts website. The website compiled data from the American Community Survey conducted by the U.S. Census Bureau.

All of the data from the above sources was entered into an Excel 2016 Spreadsheet as well as a SPSS workbook, and categorized by the corresponding 120 Kentucky counties.

DATA ANALYSIS AND MAPPING

Descriptive statistics were run using SPSS Statistics 23, and the mean, minimum, maximum, range and standard deviation were calculated (Table1). Correlations were run on all the variables in Microsoft Excel 2016 using the Data Analysis Tool Pak available for Excel (Table 2). Graphs with each of the variables was also prepared in Excel to demonstrate the correlation between the variables. (Figures. 7, 9, 11, 13, 15, 17, 18, 19). Mapping was done using ArcGIS 10.3, and for the purpose of mapping the County polygon shape file was obtained from the Kentucky geoportal website at ftp://ftp.kymartian.ky.gov/county/ (Figures 1-5, 6, 8, 10, 12, 14, 16)

RESULTS

From the data in Table 1, the prevalence of adult smoking is highest in Estill County (47.15%) and lowest in Oldham County (15.51%). The mean adult smoking rate is 28.86%. Lung cancer incidence rate is highest in Perry County where it is 154.3 per 100,000, and lowest in Woodford County where the rate is 72.30 per 100,000. Lung cancer mortality is highest in Perry County where the rate is 120.50 per 100,000 and lowest in Shelby County with a rate of 42.80 per 100,000. Median household income is highest in Oldham County ($83,391) and lowest in Owsley County. The percentage of high school graduates is highest in Boone County (91.89%) and lowest in Owsley County (61.42%).

In Table 2, there is a correlation of 0.33 between smoking and lung cancer mortality and 0.26 between smoking and lung cancer incidence. Smoking is inversely correlated with education and income at -0.39 and -0.49 respectively. Lung cancer incidence is inversely correlated with both education and income at -0.60 and -0.51 respectively. There is an inverse correlation between lung cancer mortality and both education and income with their respective correlation coefficients of -0.63 and -0.58.

Figures 1-5 show the distribution of the variables across the Kentucky counties. In Figure 1, the counties with highest level of smoking are, Estill, Monroe, Owsley, Robertson, Henry, Floyd, Wolfe, Lincoln, Cumberland and Letcher. The counties with the lowest level of Smoking are Oldham, Washington, Woodford, Mclean, Casey, Todd, Boyle, Scott, Ohio and Hart. The five counties of Trimble, Gallatin, Nicholas, Spencer and Hickman had no data available for adult smoking percent and hence are colored red on the map in Figure 1. In Figure 2 which depicts the distribution of lung cancer incidence rates across Kentucky Counties, the counties with the

highest level of lung cancer incidence are Perry, Floyd, Magoffin, Leslie, Martin, Powell, Owsley, Menifee, Livingstone and Knox; and the counties with the lowest level of lung cancer incidence are Woodford, Fayette, Elliot, Green, Oldham, Bourbon, Crittenden, Allen, Calloway and Christian. In Figure 3 which shows the distribution of lung cancer mortality rates in Kentucky, the counties with the highest rates are Perry, Martin, Powell, Owsley, Jackson, Floyd, Casey, Leslie, Letcher and Menifee; on the other end the counties with the lowest rates are Shelby, Bourbon, Owen, Lyon, Oldham, Carroll, Elliott, Fayette, Harrison and Calloway. Figure 4 shows the distributions of median household Income across the Kentucky counties, the counties with the lowest median household income are Owsley, McCreary, Clay, Wolfe, Lee, Knox, Breathitt, Elliott, Harlan and Jackson; the counties with the highest median household income are Oldham, Boone, Spencer, Scott, Woodford, Shelby, Bullitt, Campbell, Kenton, and Anderson. Figure 5 shows the distribution of high school graduation percent across the Kentucky Counties, the counties with the lowest rates are Owsley, Leslie, Clay, Breathitt, Magoffin, Wolfe, Knox, Clinton, Bell and Perry; and the counties with the highest rates are Boone, Oldham, Kenton, Fayette, Campbell, Woodford, Spencer, Jefferson, Hardin and Daviess.

Figure 6 and 8 depict the distribution of income and education respectively, across Kentucky while the state is divided by the different levels of adult smoking rates. The map clearly shows that some counties that have low rates of smoking have high rates of education and income and counties with high rates of smoking having low rates of education and income. Similarly, the graph in Figures 7, illustrates the inverse correlation between smoking and income, and the graph in Figure 9 illustrates the correlation between smoking and education.

Figures 10 and 12 demonstrates the the distribution of Education and Income respectively, across Kentucky while the state is divided by the different levels of lung cancer incidence. The map clearly demonstrates that some counties that have low rates of lung cancer incidence have high rates of education and income and counties with high rates of lung cancer incidence having low rates of education and income. Correspondingly, the graph in Figure 11, depicts the correlation between incidence and education, and the graph in Figure 13 depicts the correlation between incidence and income.

Figures 14 and 16 represents the the distribution of education and income respectively, across Kentucky while the state is divided by the different levels of lung cancer mortality. The map clearly displays that some counties that have low rates of lung cancer mortality have high rates of education and income and counties with high rates of lung cancer mortality having low rates of education and income. Similarly, the graph in Figure 15, shows the correlation between mortality and education, and the graph in Figure 17 shows the correlation between mortality and income. The graph in Figure 18 depicts a slight positive correlation between smoking and mortality. The graph in Figure 19 depicts a slight positive correlation between smoking and incidence.

DISCUSSION

From the literature as well as the data from Kentucky, it is safe to say that socioeconomic factors have a profound effect on smoking rates as well as lung cancer incidence and mortality. As can be seen in Figures 6,8,10,12.14 and 16 counties with low education and median household income are the also the ones with the highest levels of smoking and lung cancer. For instance, not only does Owsley and Wolfe Counties have some of the highest rates

of smoking in the state of Kentucky, but also the lowest education and income. On the other end counties such as Oldham and Woodford have the lowest rates of smoking and the highest percentage of high school graduates and the highest household income. Taking lung cancer incidence into consideration Owsley and Knox Counties have the highest rates of incidence and some of lowest levels of education and income. At the other end of the spectrum Oldham, Woodford and Boone Counties have the lowest rates of incidence and some of the highest levels of education and income. The same goes for lung cancer mortality Owsley and Leslie Counties have the highest rates of mortality but some of the lowest levels of education and income, and once again counties such as Fayette, Oldham and Elliot have the lowest rates of mortality and the highest levels of education and income in the state. The positive correlation in Figures 18 and 19 can be explained by the lag time between smoking and the development of lung cancer.

LIMITATIONS

One of the major limitations of this study is that since it uses aggregate level data so it cannot be generalized to an individual living in the state of Kentucky. Health disparities between Appalachian and non-Appalachian counties have been well documented and researched and as it can be seen above there is a vast difference between them. Non-Appalachian counties having some of the highest levels of income and education and lowest rates of smoking and lung cancer, and Appalachian Counties such as Owsley, Wolfe, Perry, Floyd, Letcher etc. having some the highest rates of smoking and disease and the lowest levels of education and income.

PUBLIC HEALTH IMPLICATIONS

In the near future it would be interesting to see whether smoke-free policy and indoor smoking bans have any significant effect on the levels of smoking and lung cancer in Kentucky. As of 2016, a few counties and cities across Kentucky have implemented indoor smoking bans, and some that have implemented them have significant exemptions attached. In my opinion a comprehensive smoke-free policy is essential for the state of Kentucky because it has one of the highest rates of smoking and lung cancer in the country. Legislators and policymakers should consider it because in the long run such a ban will save a tremendous amount of money that goes towards health care spending, and will also increase worker productivity and decrease the burden on Medicare and Medicaid.

CONCLUSION

In conclusion, areas with low levels of education and income in Kentucky have some of the highest levels of smoking and lung cancer. Prevention efforts should be focused on these areas since the counties have some of the highest rates in the country and contribute significantly to the overall smoking and lung cancer rate for Kentucky. Kentucky has a long way to go to address these major health issues and one of the first steps could be either raising taxes on tobacco or implementing stringent smoke free laws.

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BIOGRAPHICAL SKETCH

Shreya Berlia was born in Mumbai, India and grew up in Kolkata, India. She earned her Bachelors of Science in Microbiology from the University of Wisconsin-Madison. Currently, she is a Masters of Public Health candidate in Environmental Health at the University of Kentucky. During her time at the university she was a Student Assistant at the Chandler Medical Center Library, as well as a Student Assistant to Dr. Lawrence Prybil in the College of Public Health and a Student Ambassador for the College of Public Health.

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APPENDIX 1- TABLES and FIGURES

Table 1. Descriptive Statistics

Variable	Minimum	Maximum	Range	Mean (SD)
Adult Smoking (%)	15.51 (Oldham)	47.15 (Estill)	31.64	28.86 (5.76)
Lung cancer Incidence per 100,000	72.30 (Woodford)	154.30 (Perry)	82.00	105.16 (17.96)
Lung cancer Mortality per 100,000	42.80 (Shelby)	120.50 (Perry)	77.70	76.18 (15.38)
Median Household Income ($)	19986.00 (Owsley)	83391.00 (Oldham)	63405.00	38526.00 (10050.02)
High School Education (%)	61.42 (Owsley)	91.89 (Boone)	30.47	78.40 (6.92)

Table 2. Correlations between the Variables

	Smoking	*Mortality*	*Incidence*	*Education*	*Income*
Smoking	1				
Mortality	0.33	1			
Incidence	0.26	0.79	1		
Education	-0.39	-0.63	-0.60	1	
Income	-0.49	-0.58	-0.51	0.86	1

Figure 1. Distribution of Adult Smoking (%) in Kentucky

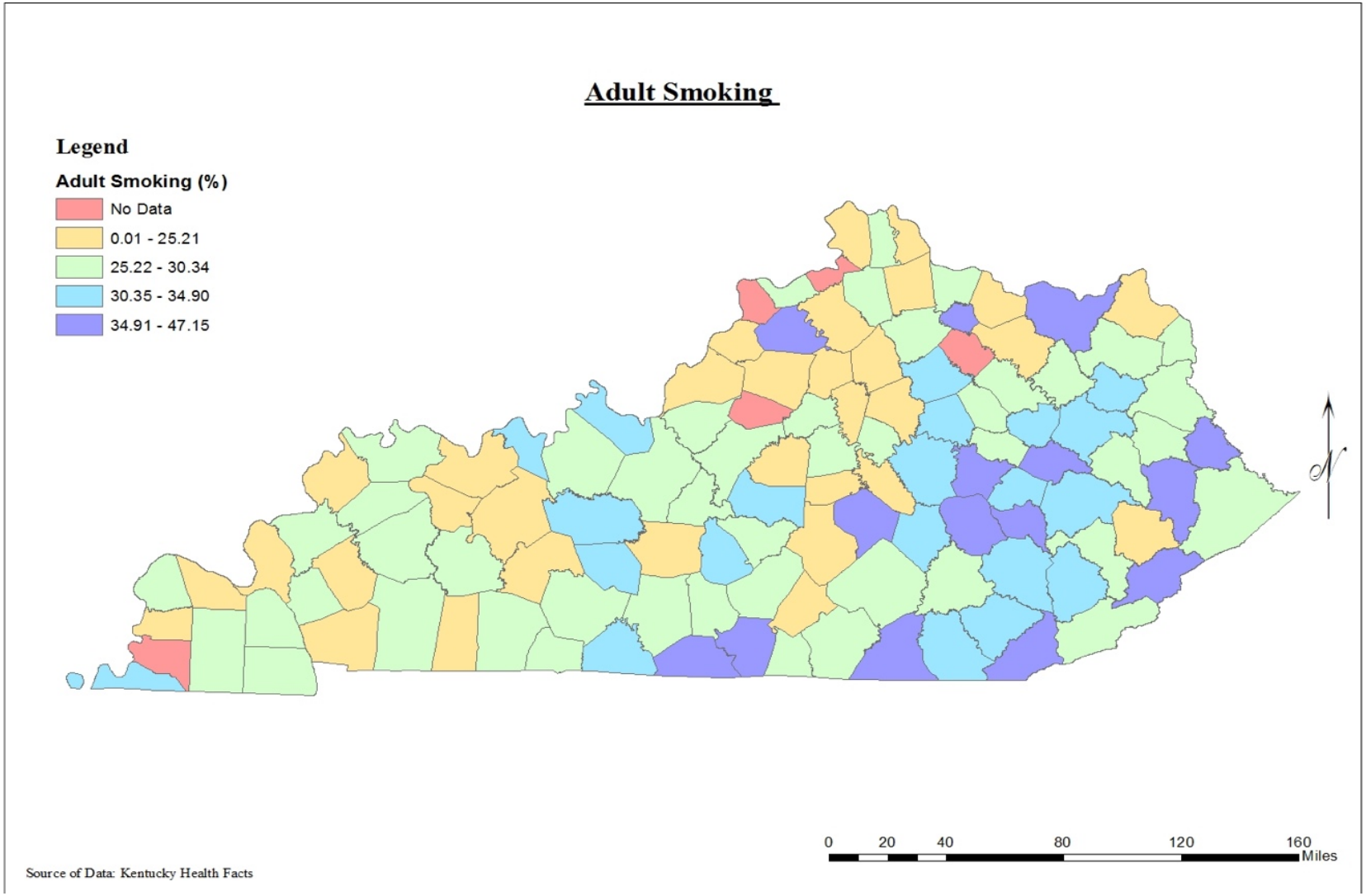

Figure 2. Distribution of Lung Cancer Incidence in Kentucky

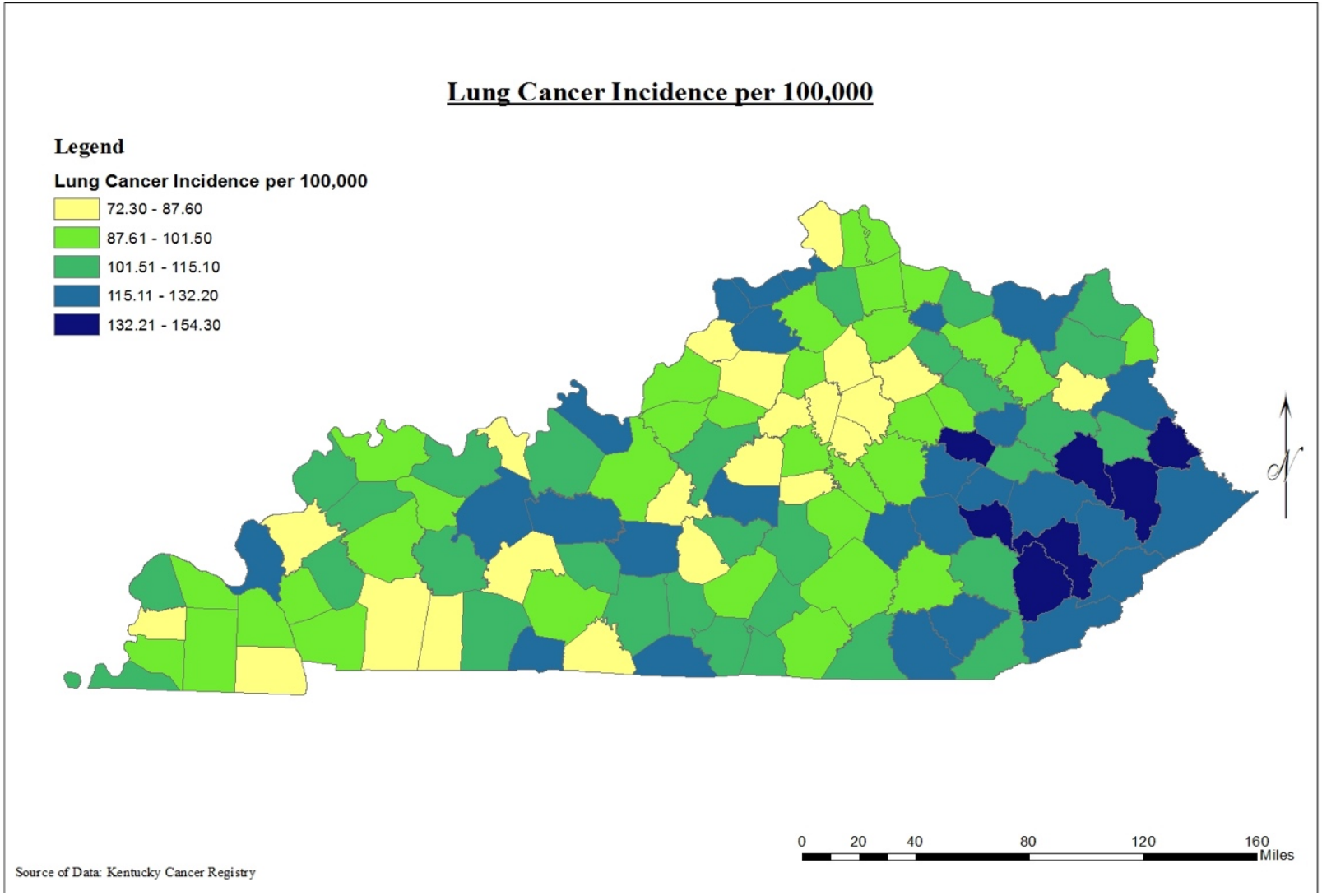

Figure 3. Distribution of Lung Cancer Mortality in Kentucky

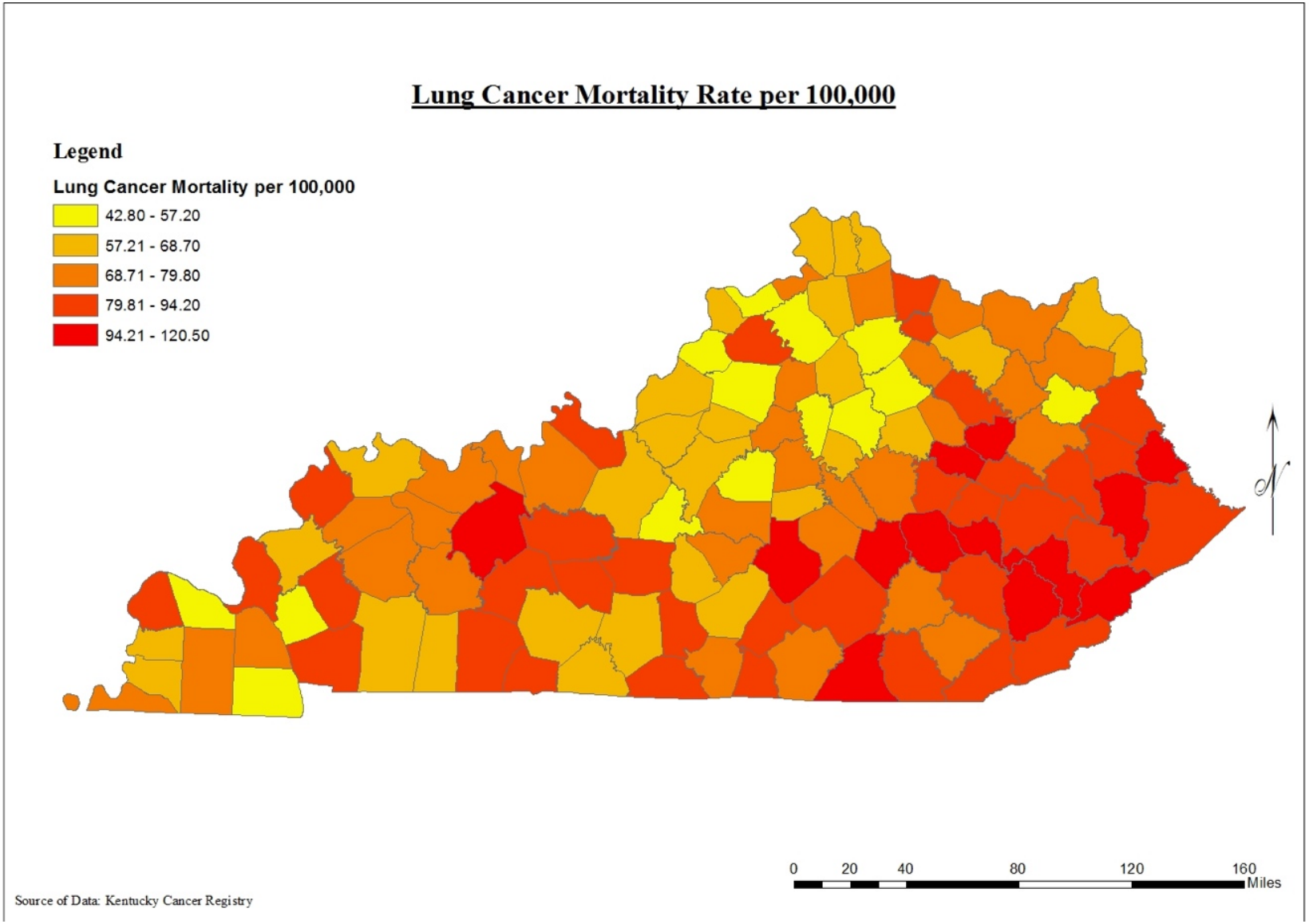

Figure 4. Distribution of Median Household Income in Kentucky

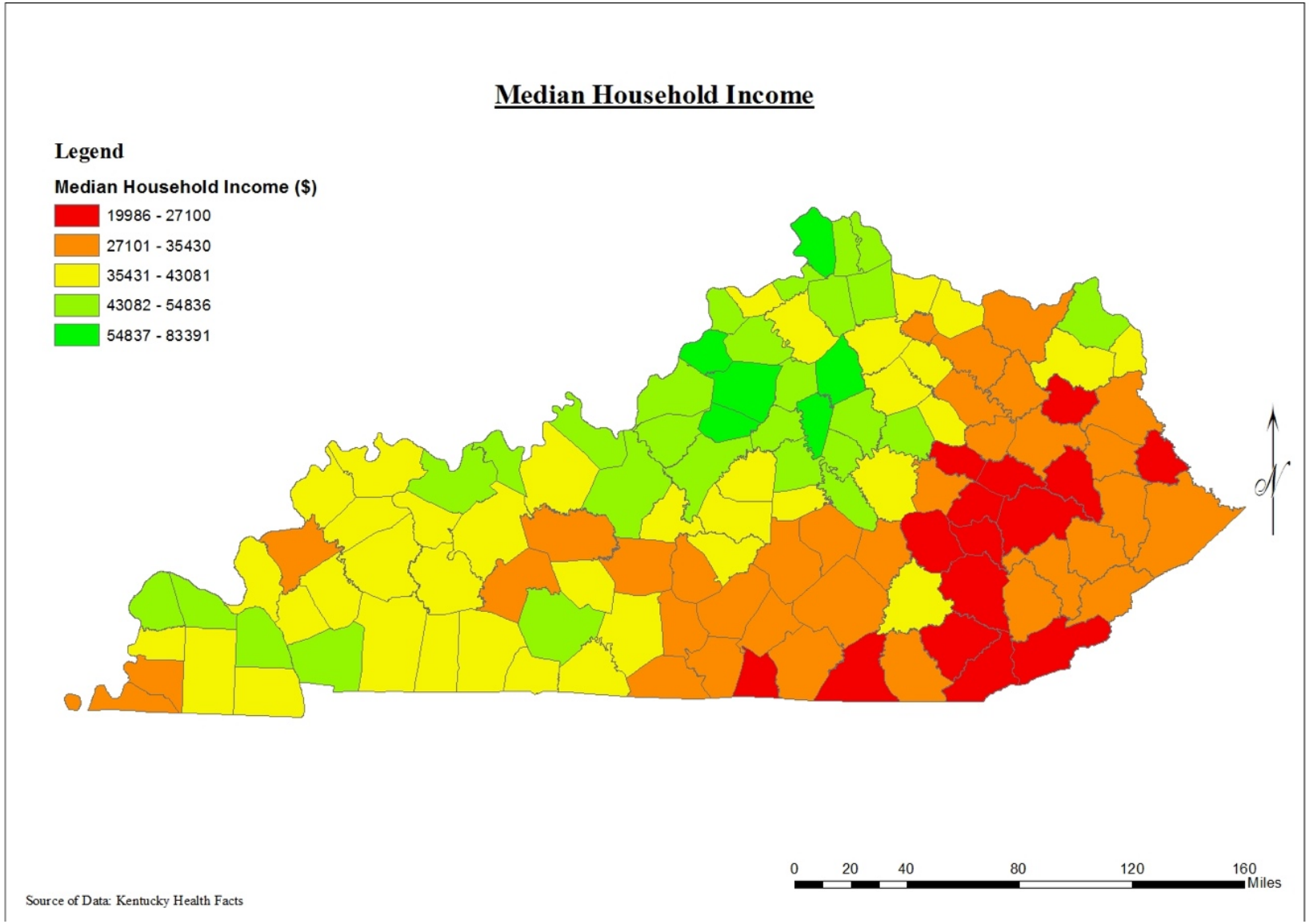

Figure 5. Distribution of High School Education (%) in Kentucky

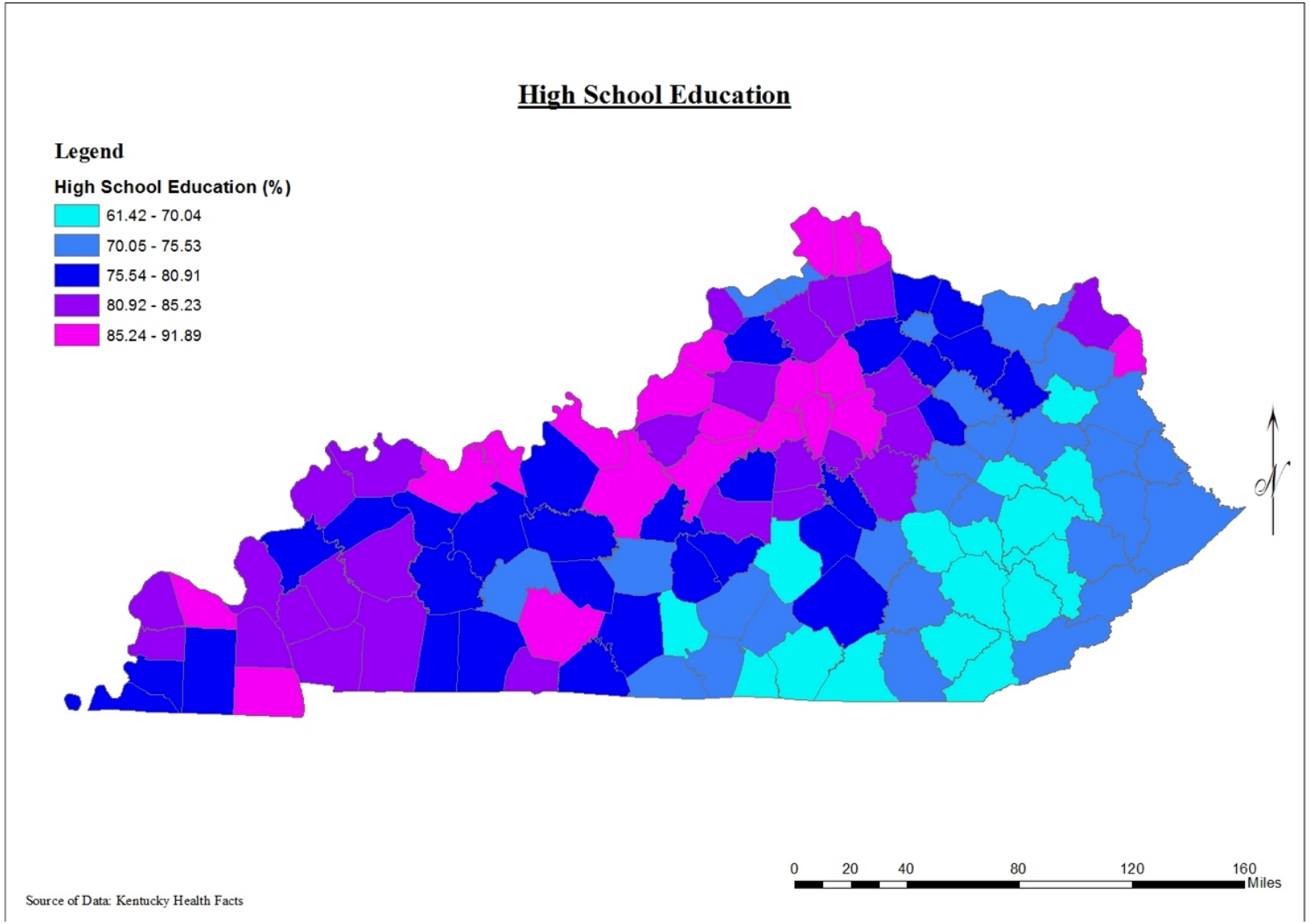

Figure 6. Adult Smoking and Median Household Income in Kentucky

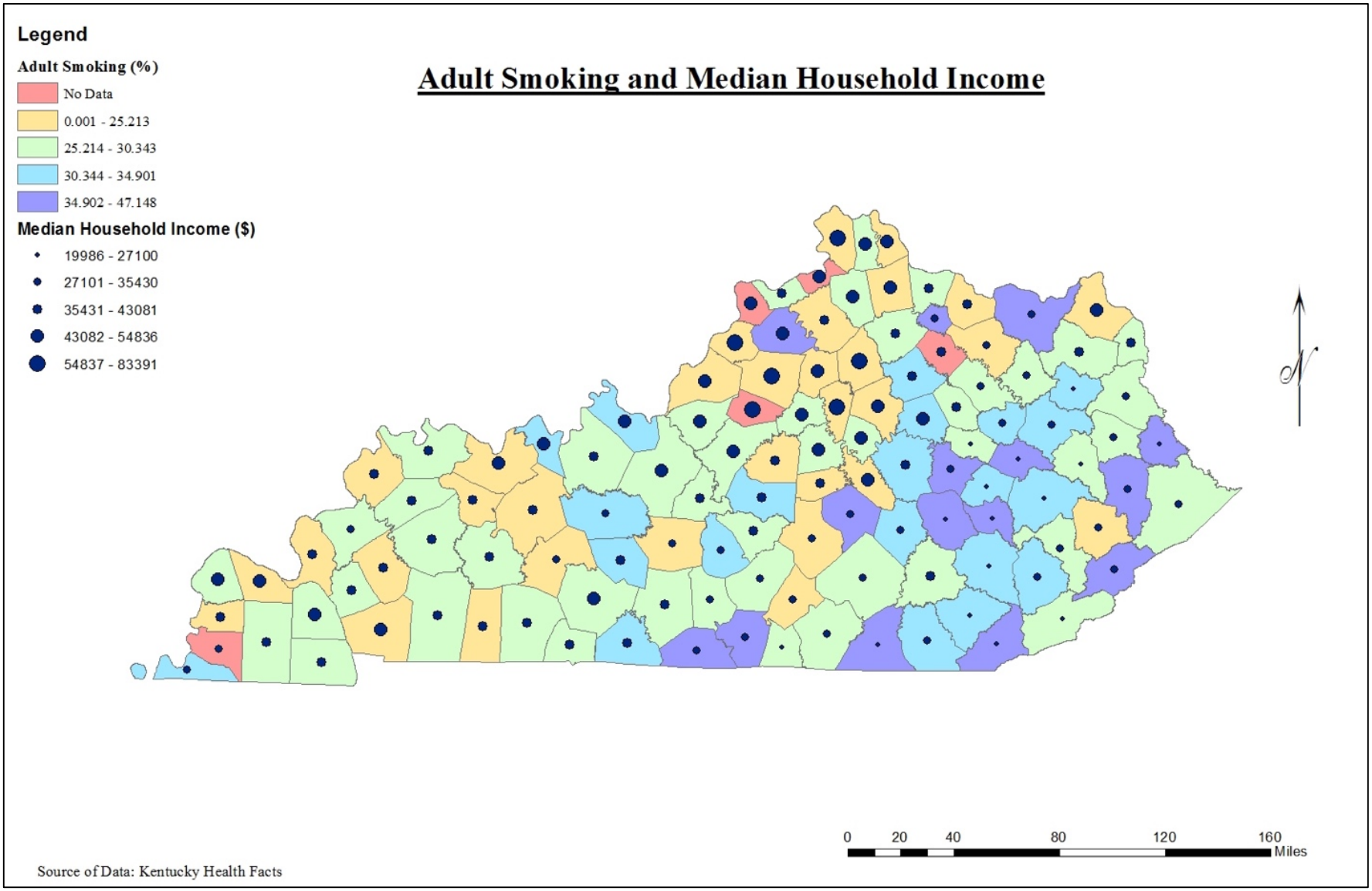

Figure 7. Correlation between Adult Smoking and Income

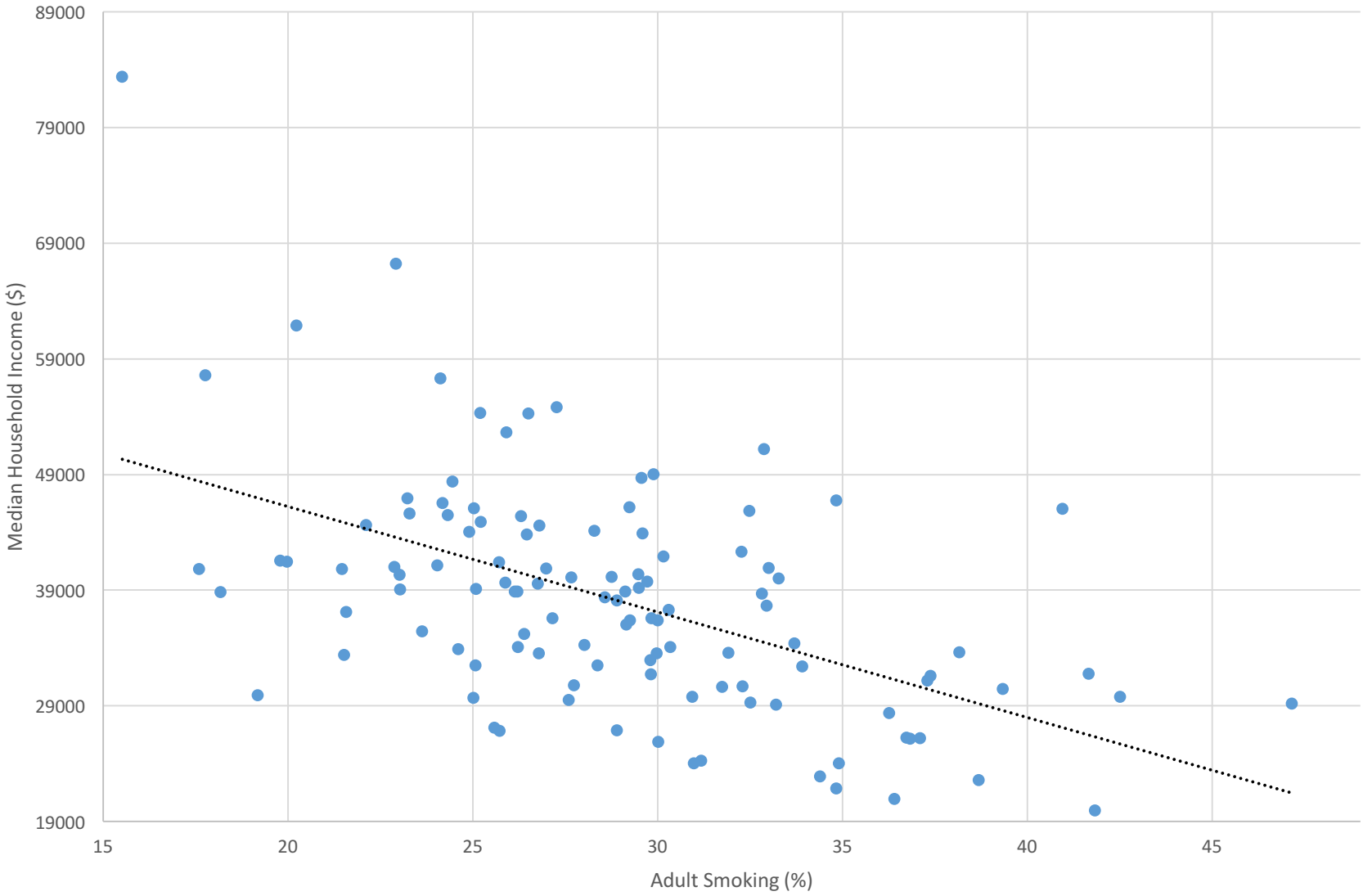

Figure 8. Adult Smoking and Education in Kentucky

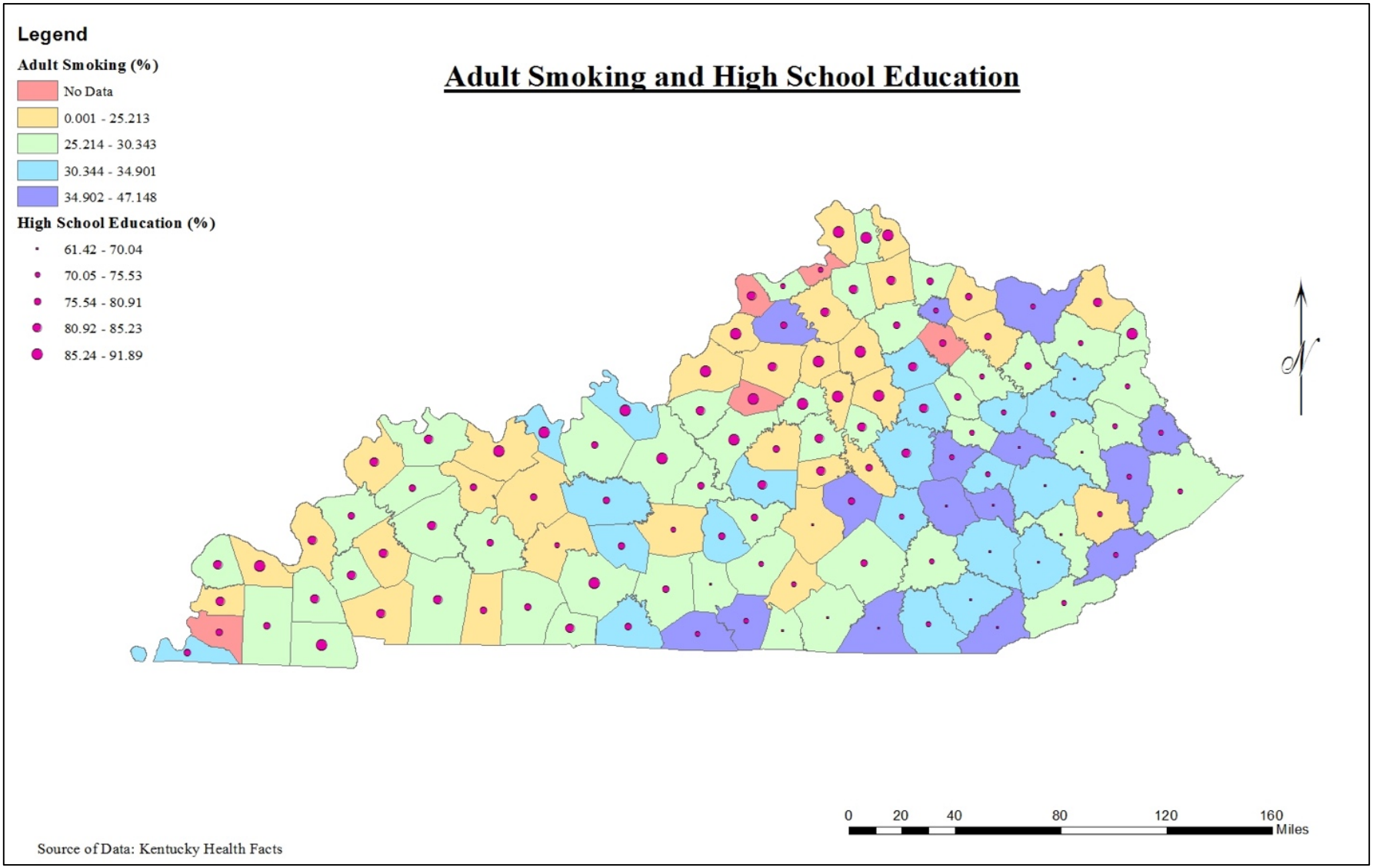

Figure 9. Correlation Between Adult Smoking and Education

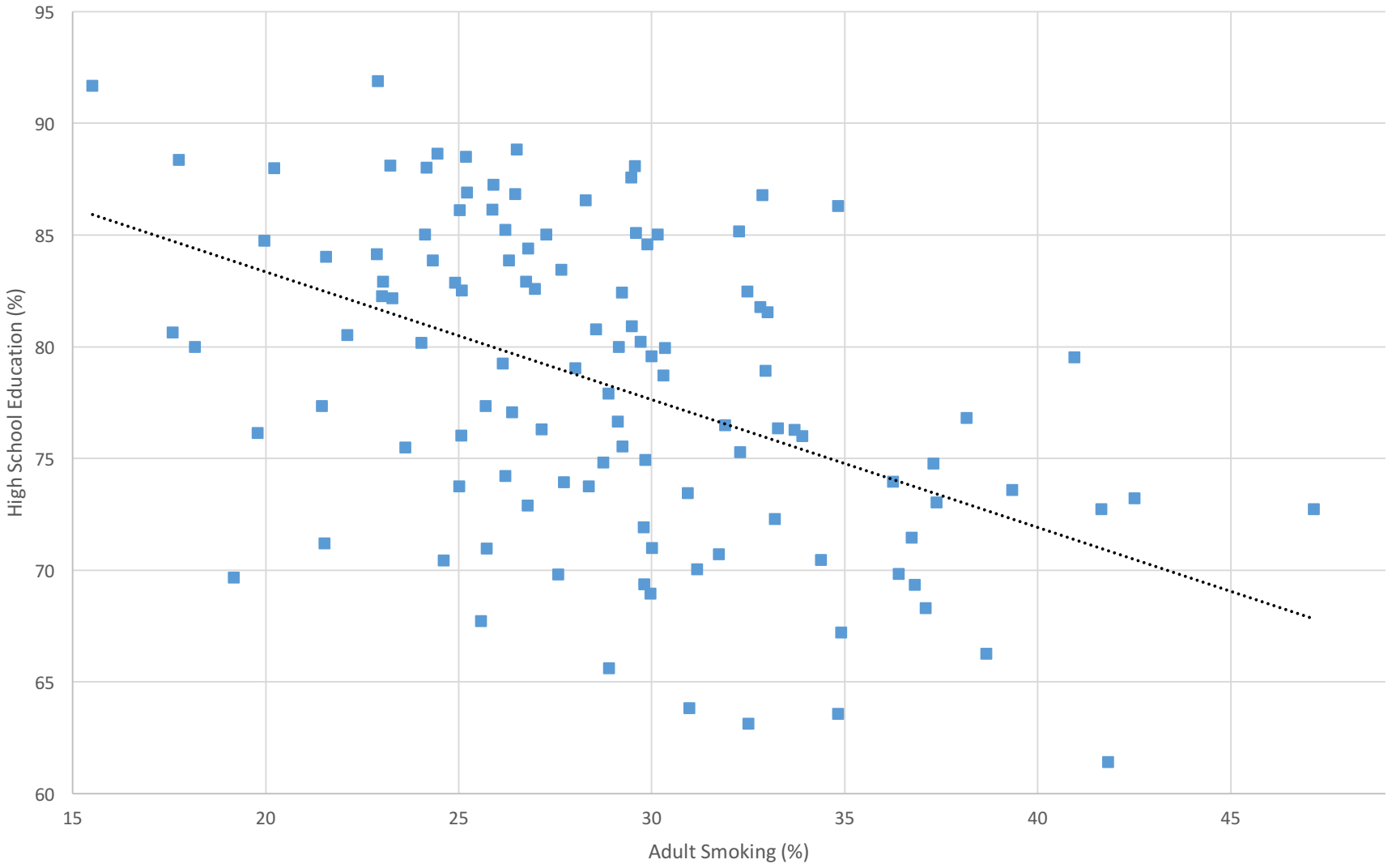

Figure 10. Lung Cancer Incidence and Education in Kentucky

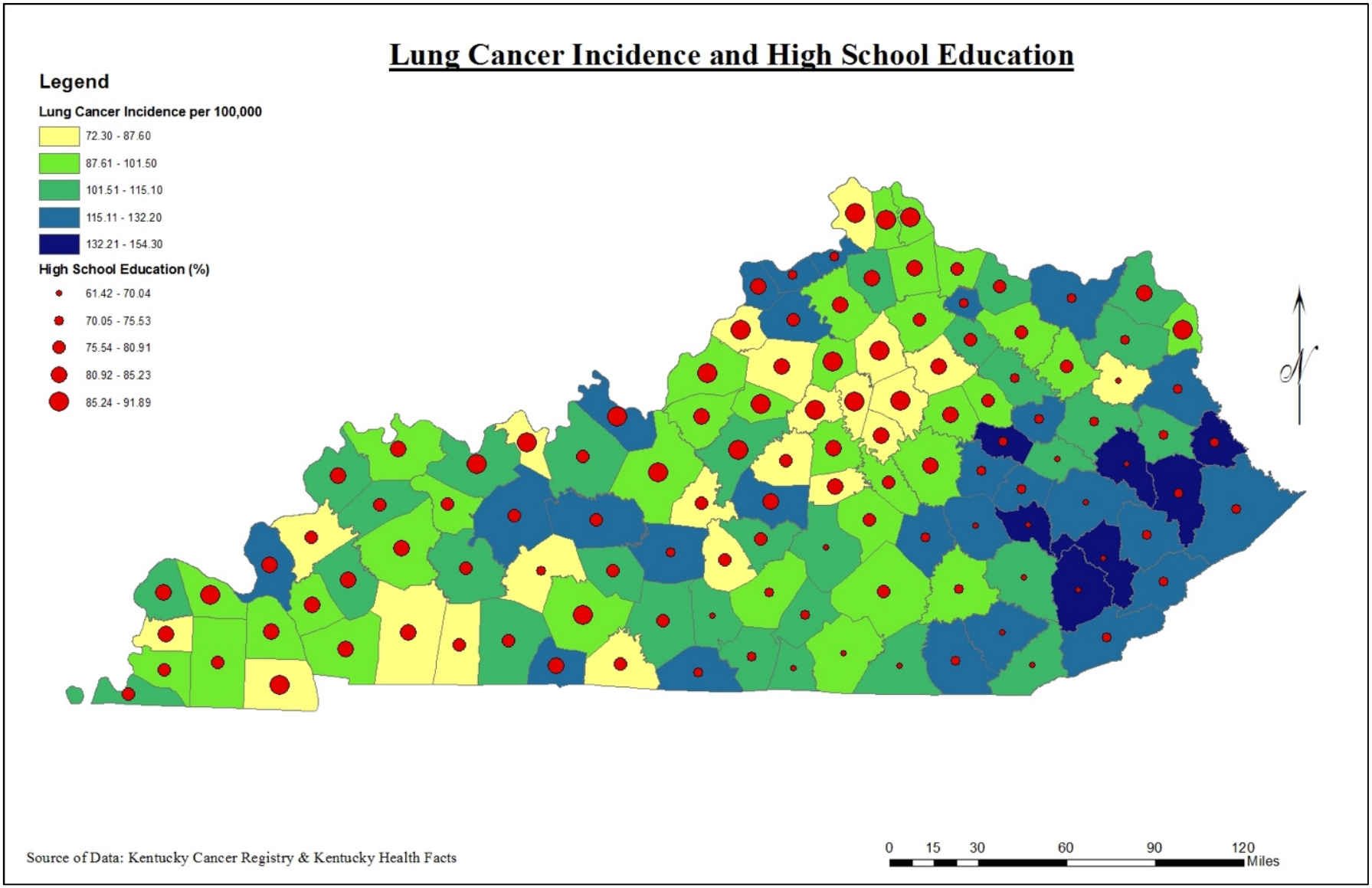

Figure 11. Correlation between Lung Cancer Incidence and Education

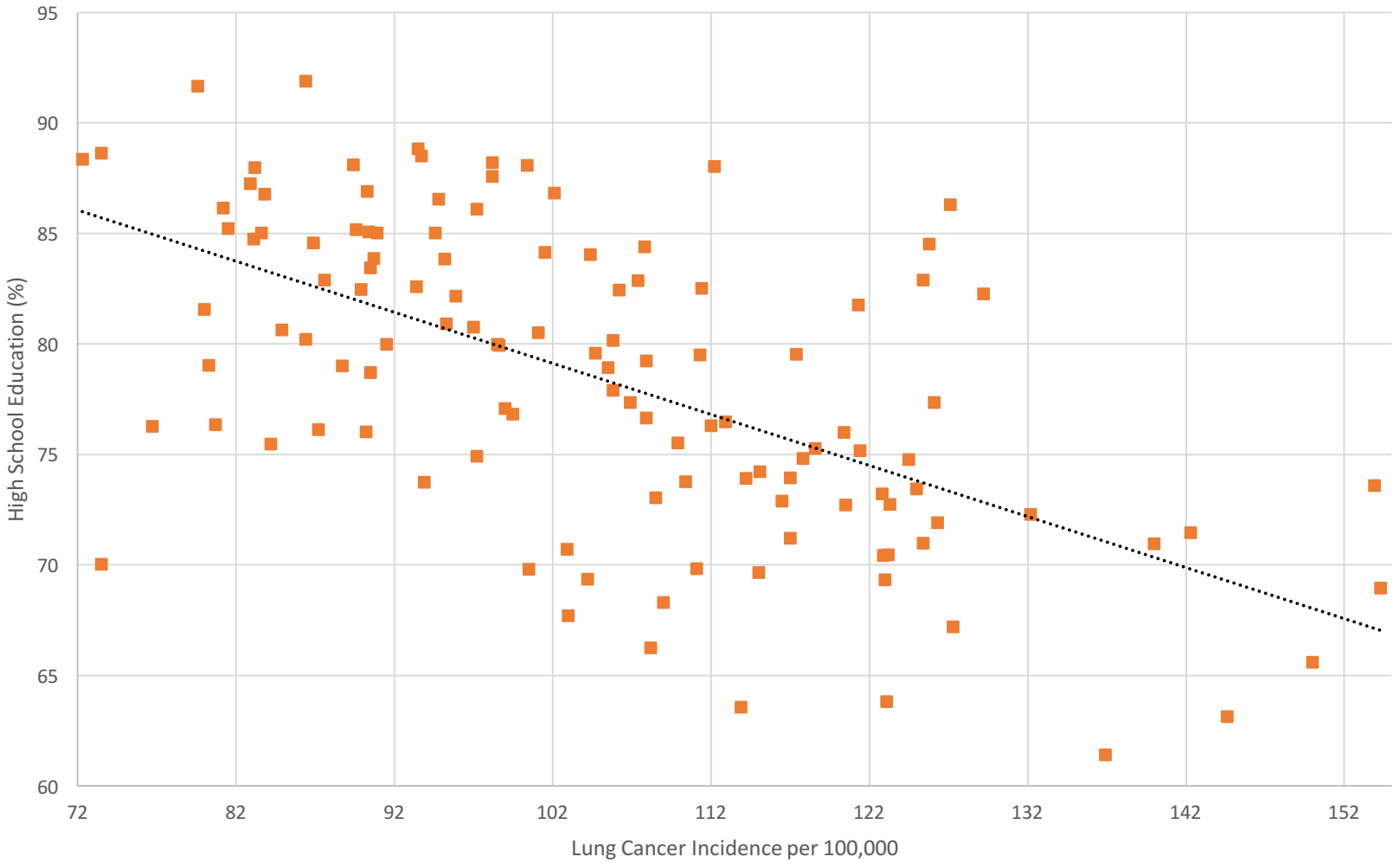

Figure 12. Lung Cancer Incidence and Income in Kentucky

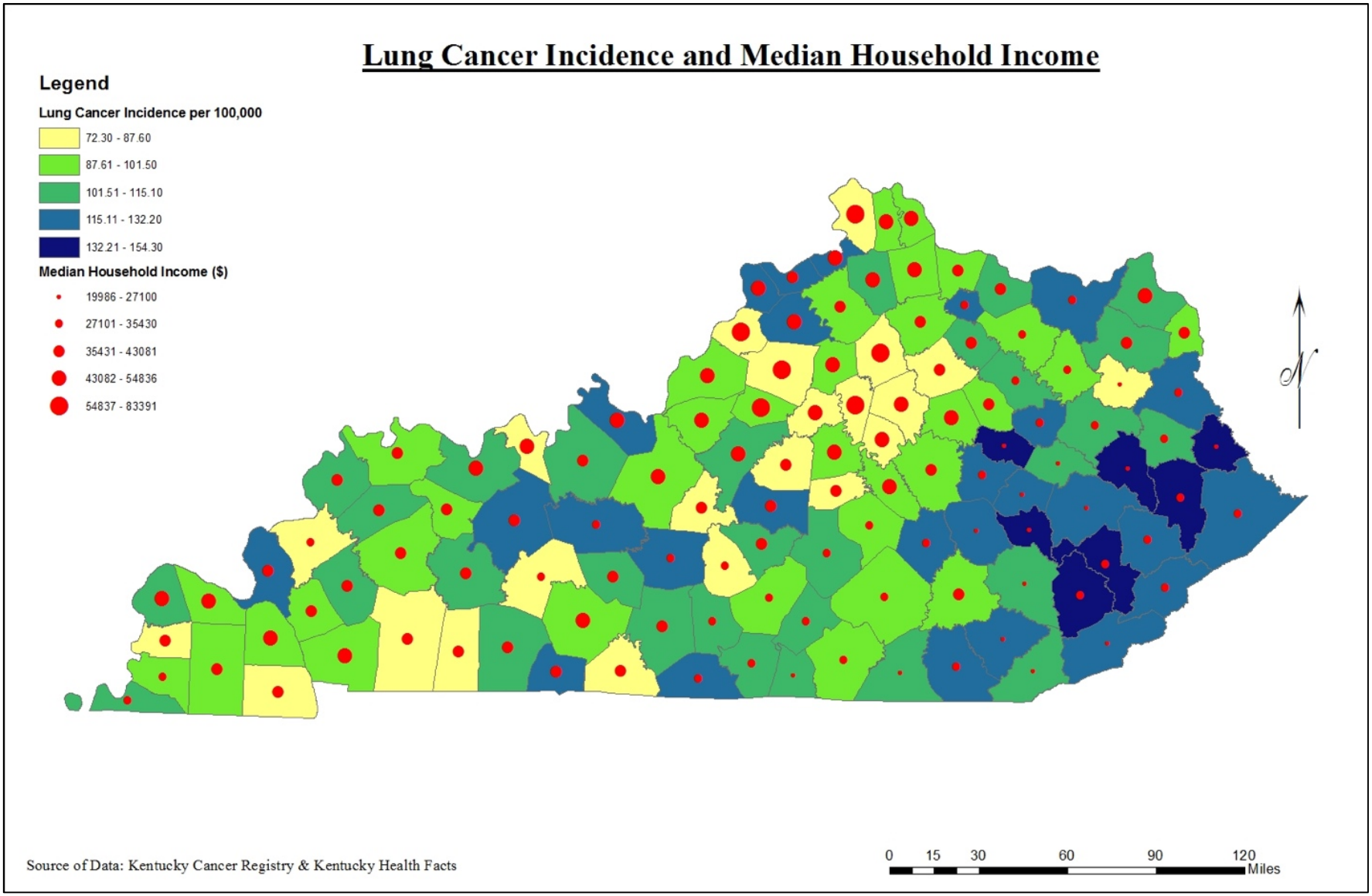

Figure 13. Correlation between Lung Cancer Incidence and Income

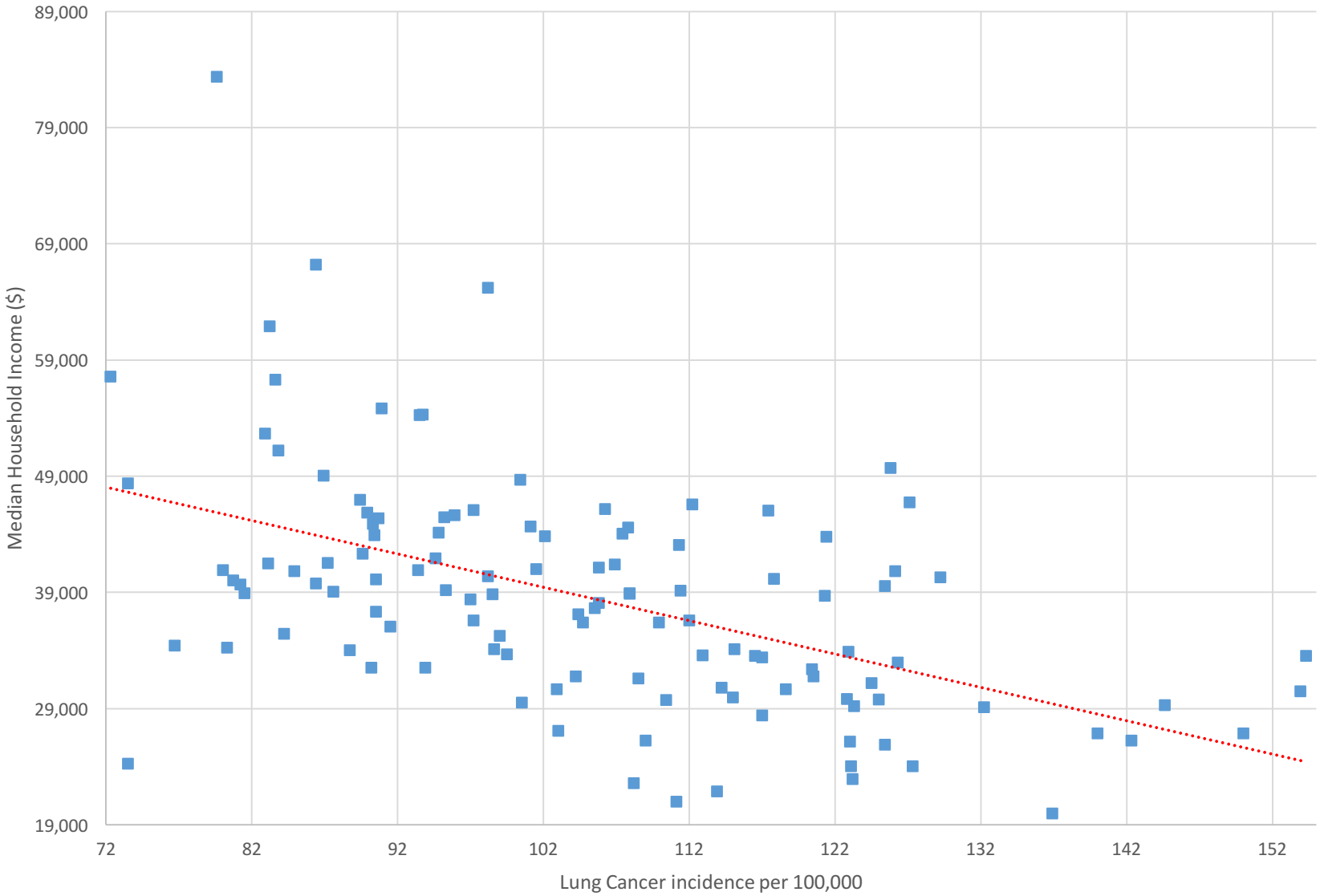

Figure 14. Lung Cancer Mortality and Education in Kentucky

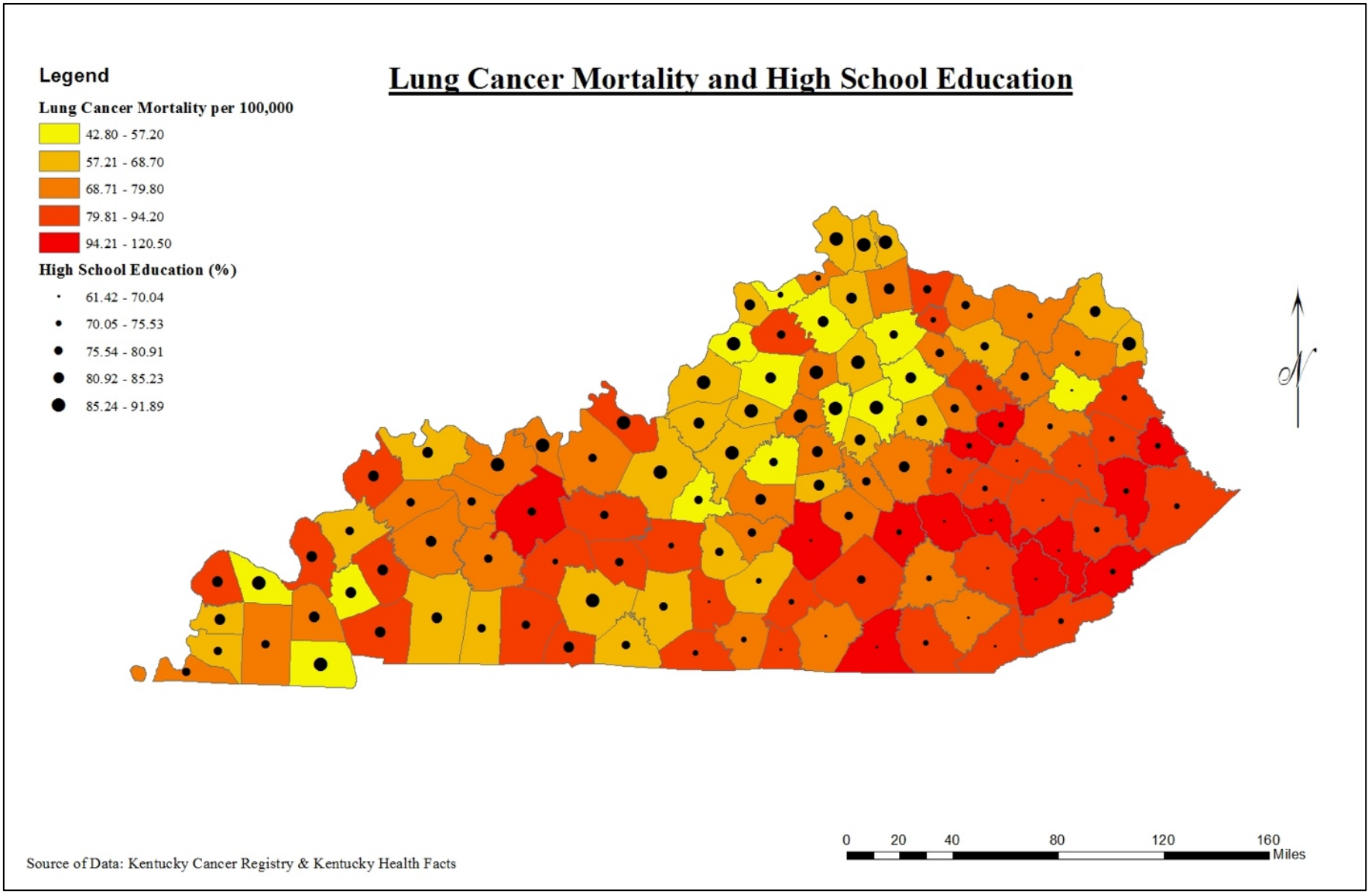

Figure 15. Correlation between Lung Cancer Mortality and Education

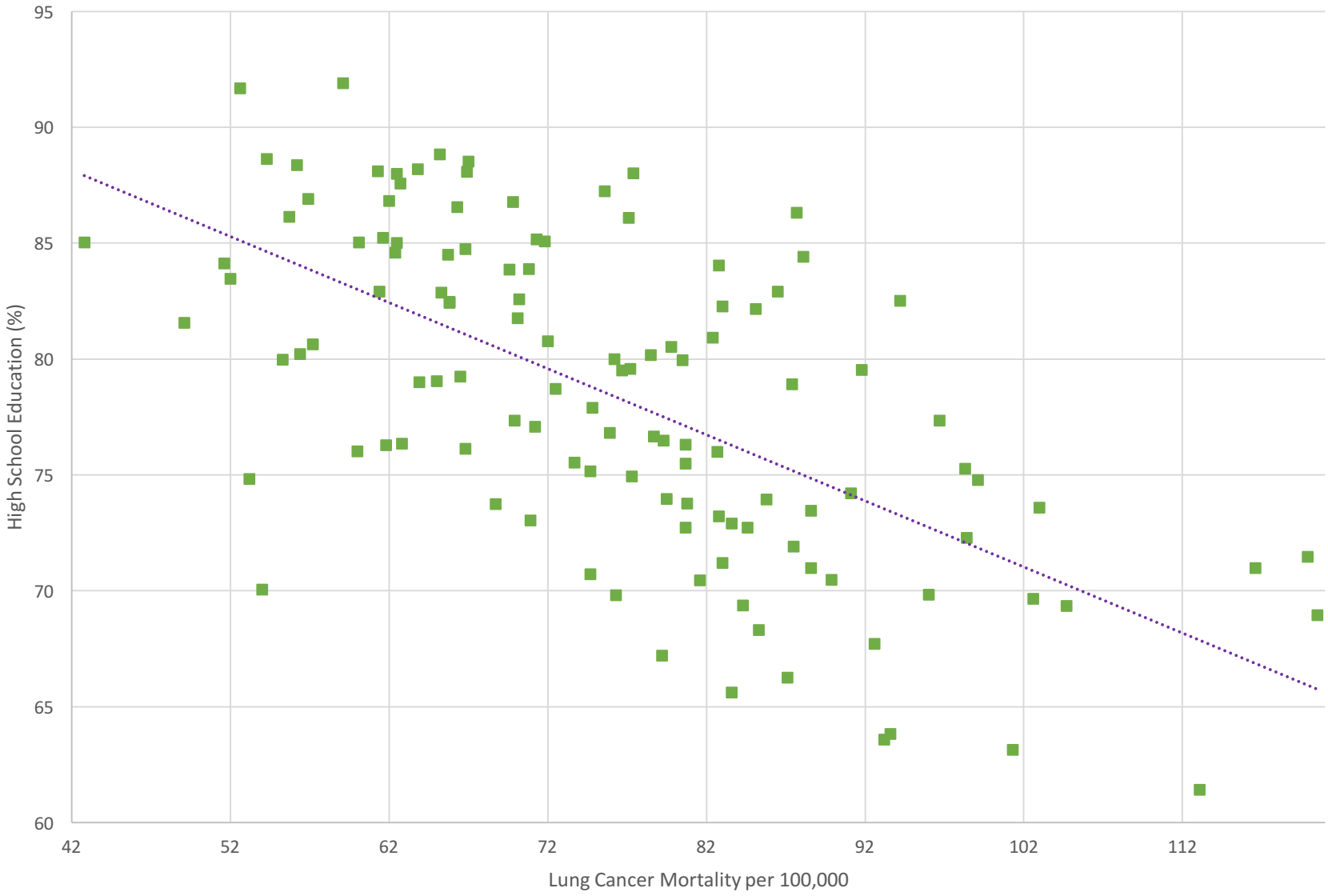

Figure 16. Lung Cancer Mortality and Income in Kentucky

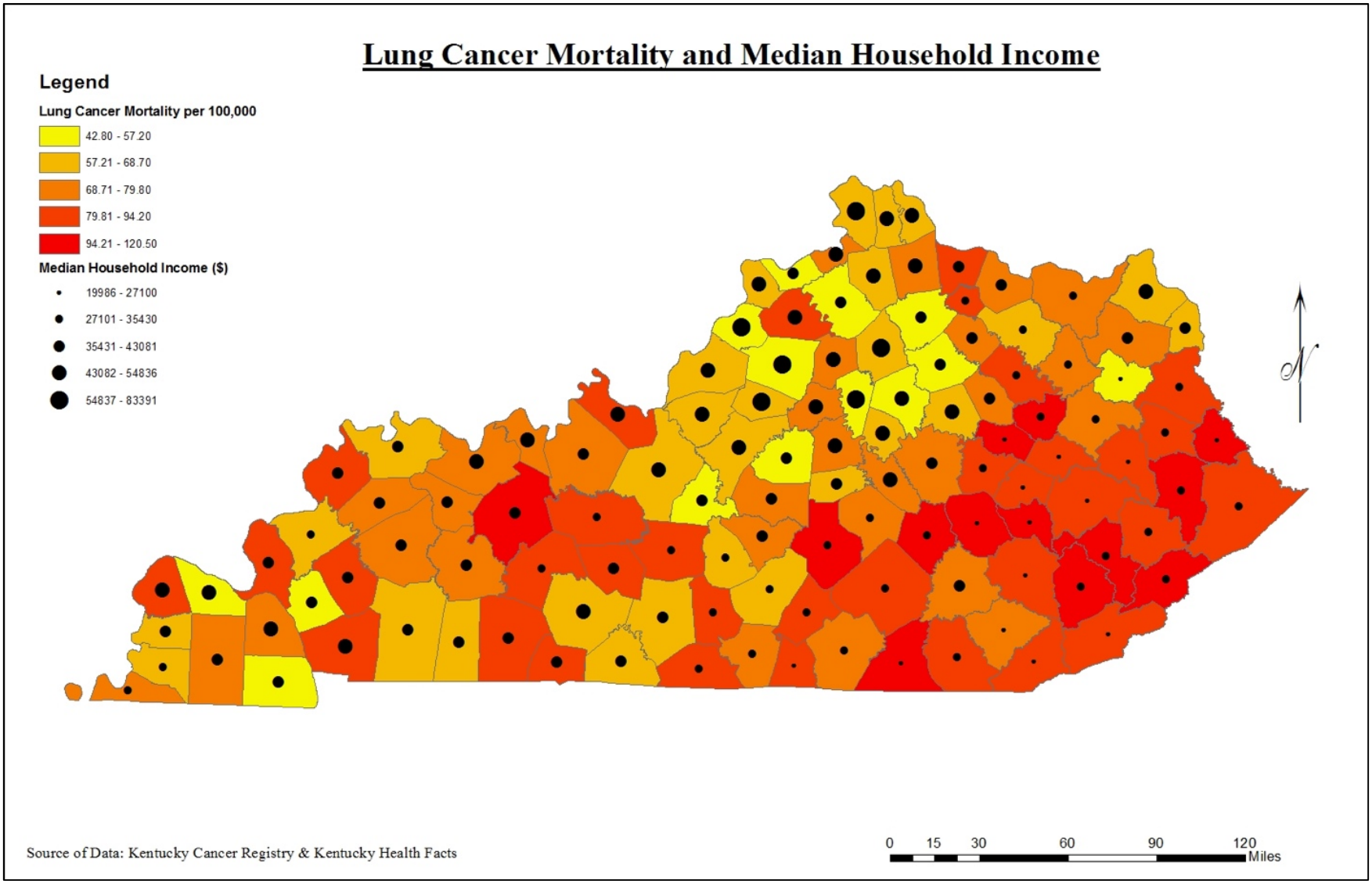

Figure 17. Correlation between Lung Cancer Mortality and Income

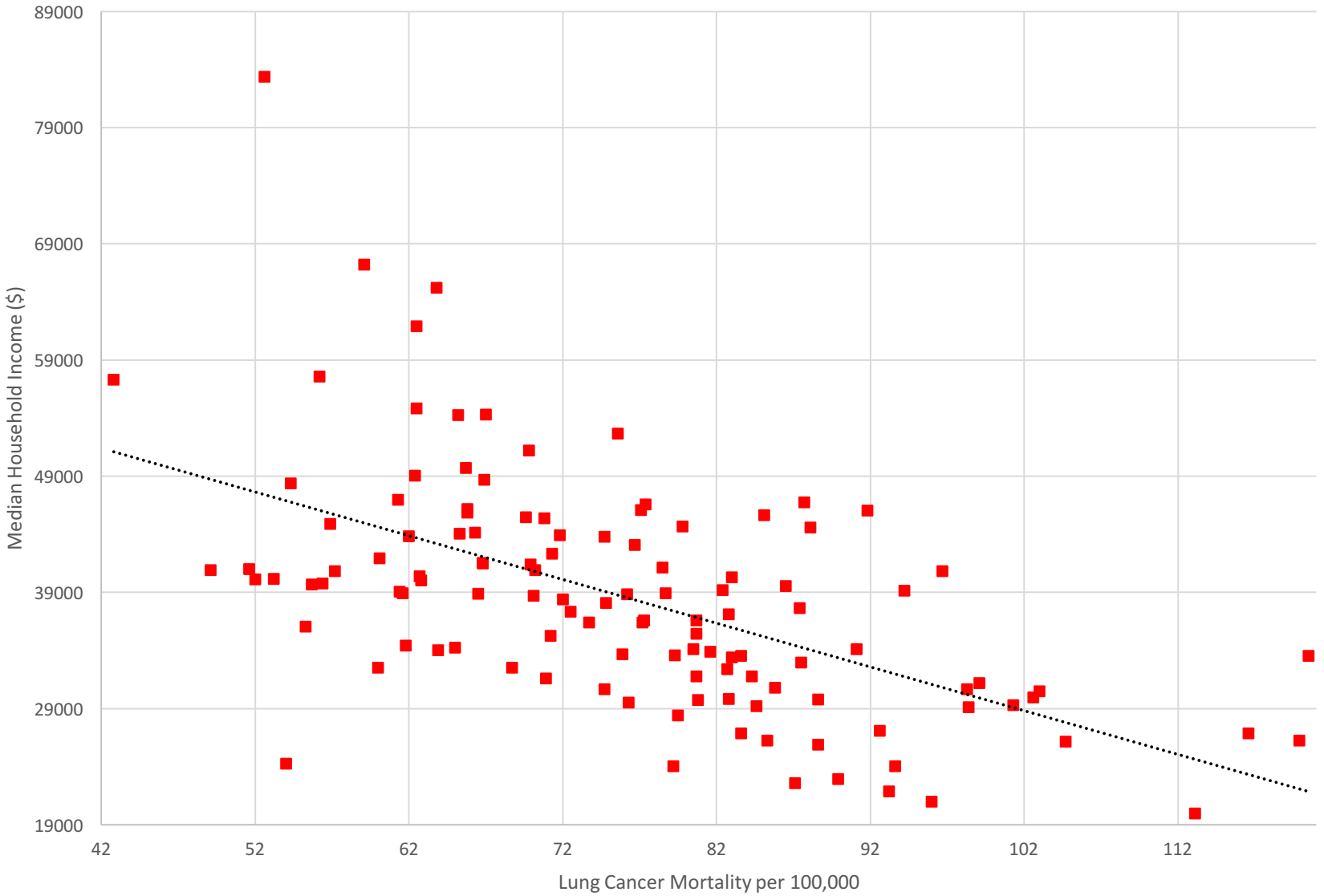

Figure 18. Correlation between Smoking and Lung Cancer Mortality

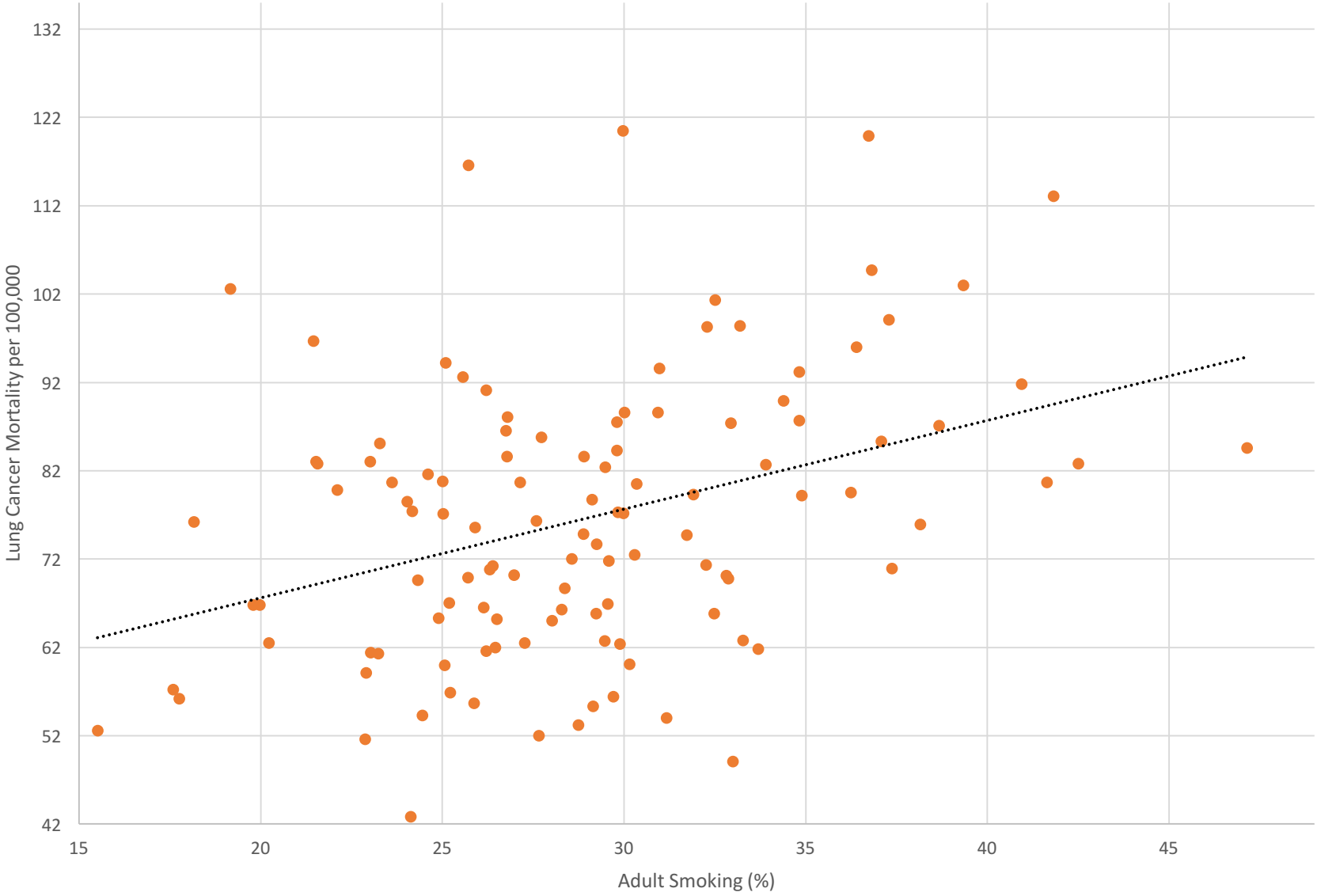

Figure 19. Correlation between Smoking and Lung Cancer Incidence